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Final Progress Report: Cost-Effective Risk Management of Groundwater Contamination

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12 a. DISTRIBUTION / AVAILABILITY STATEMENT

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12 b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This report is a final progress report for the Young Investigator Project entitled Cost-Effective Risk Management of Groundwater Contamination, which commenced on June 1, 2000. The purpose of this project is to study the relationships between human health risk and risk-based corrective action (RBCA) design for groundwater contamination under conditions of uncertainty. The objectives of the research are to: (1) elucidate the tradeoffs among risk, cost, and cleanup time, (2) develop an efficient framework for incorporating uncertainty into RBCA design decisions, (3) develop innovative methods for improving computational efficiency of the risk management model so that it can be applied at complex, heterogeneous field sites, and (4) enable technology transfer to the Army. The project is being terminated early (March 31, 2001) because the work is being transitioned to a Presidential Early Career Award for Scientists and Engineers (PECASE) project. Hence, the objectives of the project have not yet been met. A summary of progress made during the 9 months of this project is included in this report.

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Enclosure 1

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Final Progress Report: Cost-Effective Risk Management of Groundwater Contamination
Principal Investigator: Barbara S. Minsker, Ph.D.
University of Illinois, Urbana, Illinois

(1) Foreword: This report is a final progress report for the Young Investigator Project DAAD19-00-$\textbf{1}$-0389, which commenced on June 1, 2000. The project is being terminated early (March 31, 2001) because the work is being transitioned to a Presidential Early Career Award for Scientists and Engineers (PECASE) project. Hence, the objectives of the project have not yet been met.

(4) Statement of the Problem Studied: The purpose of this project is to study the relationships between human health risk and risk-based corrective action (RBCA) design for groundwater contamination under conditions of uncertainty. The objectives of the research are to: (1) elucidate the tradeoffs among risk, cost, and cleanup time, (2) develop an efficient framework for incorporating uncertainty into RBCA design decisions, (3) develop innovative methods for improving computational efficiency of the risk management model so that it can be applied at complex, heterogeneous field sites, and (4) enable technology transfer to the Army. These objectives are being accomplished by completing development of a risk management model, using a multiobjective, noisy genetic algorithm that is robust under conditions of uncertainty. Computational efficiency of the model is being improved using four innovative methods: implementing advanced linkage learning genetic algorithms, developing a hybrid genetic algorithm, parallelizing the model, and creating fast adaptive metamodels using simulation data generated during a genetic algorithm run. The results of this research will be transitioned into the Groundwater Modeling System at the USAE Waterways Experiment Station at the end of the PECASE project.

(5) Summary of the Most Important Results: Considerable progress on the proposed statement of work has been made in the 9 months of this project. The first task of the project was to complete development of the risk management model. Subtask 1.1, which involved replacing an existing simulation model with RT3D and Modflow, has been successfully completed. Subtask 1.2, which involves adding an aboveground treatment cost function and a third objective function for minimizing cleanup time, has been partially completed. Cost functions for above ground treatment using a variety of treatment approaches and contaminants have been developed using RACER software. The cost function for the air stripping technology has been implemented in the model. The remainder of Task 1 will be completed under the PECASE project. Task 2, which involves investigating methods for improving computational efficiency of the model, has also been partially completed. For Subtask 2.1, investigating linkage learning genetic algorithms, C^{++} code for the extended compact genetic algorithm (ECGA) has been obtained from the developers of the method. The code is currently being modified to accommodate the risk management fitness function; the modifications will be completed under the PECASE project. Under Subtask 2.2, an efficient, self-adaptive hybrid genetic algorithm (SAHGA) has been developed for another project that will be adapted to this model next year. For a complex, multimodal test fitness function, the SAHGA required over 75% fewer function evaluations than the simple genetic algorithm to identify the optimal solution. For computationally-intensive applications such as the risk management application studied in this project, such reductions would have substantial benefit, allowing more complex sites to be studied. Under Subtask 2.3, implementing the management model in parallel, significant progress has been made. The

simple and multiobjective genetic algorithm solvers have been implemented in parallel (using MPI) on the National Center for Supercomputing Application (NCSA) SGI Origin with a simple test fitness function. The risk management fitness function and associated simulation models are currently being implemented in parallel; the implementation will be completed under the PECASE project.

(6) Listing of Publications: No publications have been completed under this grant. The work completed under this grant will be published under the PECASE grant.

(7) List of Participating Scientific Personnel:

Barbara S. Minsker, Principal Investigator
Rachel Arst, Graduate research assistant
Jun Lee, Graduate research assistant

From: Barbara Minsker <minsker@uiuc.edu>
To: usaro.rtp(reports)
Date: Mon, Jan 29, 2001 10:16 AM
Subject: Final progress report: Grant DAAD 19-00-7-0389

Attached please find the final progress report and ARO Form 18 for Grant
DAAD 19-00-7-0389, entitled Cost-Effective Risk Management of Groundwater
Contamination. Please note that this project is being terminated early
(March 31, 2001) because the work is being transitioned to a Presidential
Early Career Award for Scientists and Engineers (PECASE) project. Hence,
despite this being a final progress report, the objectives of the project
have not yet been met. A summary of progress during the 9 months of this
project is included.

Please contact me if you need any further information.

Sincerely,
Barbara Minsker

CC: Jeff Holland <hollanj@wes.army.mil>